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PLANS AND ESTIMATES
OF A
NEW SYSTEM OF WATER-WORKS
FOR THE
CITY OF CLINTON IOWA

by

JENT GEORGE THORNE

A Thesis Submitted for the Degree of
CIVIL ENGINEER

UNIVERSITY OF WISCONSIN
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Report to the City Council of the City of Clinton, Iowa, upon the cost of a complete water works system and an explanation of water rates.

To the Honorable Mayor and City Council
of the City of Clinton, Iowa.

Gentlemen:-

As per resolution of your honorable body passed on the 13th day of June 1916, I herewith submit my report and plans for a complete new system of water works together with an analysis of water rates.

1. QUANTITY OF WATER REQUIRED.

The first question to be decided when planning a system of waterworks is the quantity of water which will be required both for present needs and for a certain period in the future. To aid in solving this problem we have prepared a population curve (Plate 1) showing the population of Clinton from 1885 to 1915 and the probable number of inhabitants up to 1965. The total quantity of water estimated to be consumed in the future will be only approximate but with the probable increase of population in mind plans can be drawn which will make due allowance for future extensions without unnecessary expense.

Consumption of water is usually stated in terms of the average number of gallons per capita on the

total population. This includes all water supplied whether it be used, wasted or lost through broken pipes or mains. The different classes of users of water may be divided into (1) Domestic, (2) Commercial, (3) **Public** Use and (4) Loss and Waste. Under the heading of Domestic~~e~~ is included residences, apartment and boarding houses; Commercial includes office buildings, stores, railroads, sugar refineries, factories, elevators and hotels; Public Use includes schools, street sprinkling, sewer flushing, water troughs, foun~~d~~tains and fires; Loss and Waste includes loss due to bad plumbing, leaky [illegible] means, waste to prevent freezing and wilful waste. The number of gallons per capita used by each class of consumers can be estimated from the records of other cities which give the average amounts as follows:

Domestic..............	35	gallons	per	capita	per	day.
Commercial............	80	"	"	"	"	"
Public Use............	10	"	"	"	"	"
Loss..................	25	"	"	"	"	"
TOTAL.	100	"	"	"	"	"

In computing the maximum ordinary rate we have accordingly used 100 gallons per capita per day with the population increasing from 26,600 at the present time to 40,000 in 1965.

2. SOURCES OF SUPPLY.

The natural sources of water supply for the City of Clinton are the Mississippi River and artesian wells.

Where the amount of water from wells is not sufficient to supply a city recourse must be made to surface supplies. The Mississippi River with its vast amount of water immediately suggests itself as a source of supply. Many of the larger cities are using filtered Mississippi River water with good results. In making the plans for the pumping station (River Supply) we have made use of settling basins, filter beds and a clear water reservoir. A coagulent is to be used in the settling basins. Where space is limted the rapid sand or mechanical filters are generally used instead of the slow sand filters. We have used the slow sand filters in estimating for the purpose of comparing its cost with that of the well supply. Little need be said concerning the quality of water supplied by the artesian wells. The wells furnish a pure hard water but can not be depended upon to furnish an unlimited amount of water. For this reason we have located the pumping station for both the well supply and river sup-

ply in the same place in the north part of the City. By following this plan a change from well supply to river supply can be made without moving the pumping station and relaying the large mains.

3. SAND FILTRATION.

(a) Bacterial efficiency of slow sand filters runs as high as 99.5%. The process is more than a mere straining out of the suspended particles by the sand layers. The efficiency of a sand filter increases with age until such time as the upper layer of sand has to be removed. The cost of operation of the sand filters including claning beds and laboratory expenses is about $2.35 per 1,000,000 gallons.

(b) The rapid or mechanical filters are designed to accomplish results comparable with those obtained by the slow sand filter but requiring a much smaller area. Like the slow sand filters the mechanical filters consist of a bed of sand or quartz but in other respects the construction and operation are very different. Method of operation and mechanical details are largely covered by patents. A coagulent is used to aid in filtration and the bed is washed by forcing water in the reverse direction through the sand. From 100 to 125 million gal-

lons of water per acre per day can be obtained by use of this type of filter and with careful attention to the filters and settling basins an efficiency as high as 99% can be obtained. Mechanical filters are especially adapted to those cases where the cost of the land is high, where the water is to turbulent as to require large settling tanks and in small plans where the unit for sand filtersshould be small. For sewage-laden waters, where the annual expense of the mechanical and sand filters is equal, the sand filters are preferable, but the difference in efficiency is not great enough to warrant any great amount of additional expense.

4. DISTRIBUTING SYSTEM.

The distributing system should be designed so that it will be able to supply adeuate quantities of water with economical and reasonable security against interruption. In the design of water works systems the uses of water are divided into two distinct classes; - first, ordinary every day use, commonly classed under "Domestic, Commercial and Public" use; second, the use for fire extinguishment. The ordinary consumption is relatively uniform over the different parts of the city thru out the day.

In the case of the consumption of water for fire extinguishment however the number of gallons used is likely to be higher for the same period of time in any part of the City. As the cost of the distributing mains is the largest item of the waterworks system much care must be taken in the design of this part of the system.

5. GENERAL DESIGN.

As shown in Plante No. 2 we have divided the city into ten (10) districts, keeping each district as nearly as possible within the ward limits. The population from 1915 to 1965 is shown in each district, also the maximum ordinary rate, fire rate, total maximum, number of fire streams and the proportion of the maximum ordinary rate to the yearly average of gallons per minute.

Plate No. 3 shows a skeleton of a system designed for the present needs and with provisions for future extensions up to 1965.

In the lay-out of these main pipe lines we have provided for the largest mains to extend from the north to the south end of the city on what will eventually be the central north and south axis. On the east side of this central line we have shown an auxiliary main

extending south along the streets near the river and connecting with the main feeder on the central axis. This system can be easily expanded to the west by providing another main feeder west and parallel to the central axis. The pumping station is located on the bank of the Mississippi River, north of Eighth Avenue in Lyons. Were it not for the fact that we wish to provide for the possiblity of having to resort to the use of filtered Mississippi River water as the supply, we would have placed the pumping station in a more central location so as to give a more equal distributing pressure and reduce the size of the mains. However with the pumping station in this location all contingencies are accounted for and with the mains once in place the system will be good for an indefinite length of time. Plate No. 4 shows the method used in designing the size of the various pipe lines of the main distributing system. From the total number of gallons per minute in each pipe line and the economical velocity, we are able to obtain the size of pipe in inches and also the total loss of head.

6. ELEVATED TANK.

As we progress from District 1 toward the south, the pipe lines gradually decrease in size until we reach the elevated tank in Olney Avenue in Section 10. The plans call for a 1,000,000 gallon elevated steel tank on a steel tower located on the highest spot in the south part of the system. This tank will serve both as a reservoir and as an equalizer of pressure. It provides a constant head to be pumped against, also will furnish water for a brief period in case the pumps are out of commission.

When the different parts of the city vary considerably in elevation, it is often thought advisable to divide the system into two or more independent parts, each serving a definite area or zone. In Clinton, the total area can be supplied in one zone by the use of direct pressure pumps and elevated tanks. Future extensions can be made to provide for new territory and additional pumping stations can be installed at various points through out the system. The hydrants are conveniently located so as to give convenience of access in case of fire. Hydrants are usually placed on the same side as the pipe lines and are connected to the larger of two mains, not smaller than six (6) inch, when there is a choice.

In order to prevent freezing we have designed the mains to be placed at such a depth as to be covered with six (6) feet of earth. The large mains are not likely to freeze but should be placed at the same depth so as to aid in maintaining the temperature of the water. Service pipes are 5/8" and 3/4" extra heavy lead running from the main to the curb line; brass corporation cock is screwed into the main and also a stop cock with a suitable valve box is placed back of the curb. No allowance for sprinkler connections has been made in the estimate of this sytem, the sprinklers being very few in number, usually of four or six inch cast iron pipe and are to be paid for by the property owners.

7. THE ESTIMATE.

In making up the plans and estimate for this system we have estimated the cost in four different ways Plans A - B - C - D.

Plan "A" provides for a river supply with 73 miles of mains and 758 hydrants which provides water mains for every street in the City on which there is a building at the present time.

Plan "B" provides for a well supply with 73 miles of mains and 758 hydrants.

Plan "C" provides for a river supply with 56 miles of mains and 494 hydrants. The 56 miles of mains and 494 hydrants as colored in red on the large maps of the system, we consider sufficient for the present needs of the city.

Plan "D" provides for a well supply with 56 miles of mains and 494 hydrants. We have estimated in this manner so as to show what the actual expense of construction, operation and maintenance would be under any of the four conditions.

(a) The largest percentage of the cost of any water works system is in the cost of the distributing mains. The cost of cast iron pipe fluctuates greatly from year to year varying from $24.00 to $38.00 per ton depending upon the demand and supply of the products of the iron industries. In estimating the cost of a plant which will require two or three years to build and which will for the most part endure for seventy-five years or one hundred years it is evident that a fair price can be arrived at only by an average price over a period of years. We have accordingly taken the base price of $33.40 per ton delivered on the streets of Clinton.

We have likewise computed the cost of the other material entering into the construction of the system allowing in each case for freight and hauling.

(b) The pipe laying and rock excavation has been estimated for each size of pipe and on each street. The estimate of the cost of the rock excavation is only approximate as no rock soundings were taken. A good estimate has been made of the amount of rock however from previous work on sewers in various part of the City.

(c) We have estimated the cost of trenching through and replacing the various kinds of pavement wherever encountered both for the mains and the connections.

(d) The house connections are planned to run from the main to the back side of the curb with an average length of twenty feet. The connection complete includes extra heavy lead, pipe, corporation cock at main and stop cock with buffalo box at the curb. We have estimated a 5/8" connection for residence and 3/4" connection for business blocks. If any property owner desires a larger connection he will have to pay the additional cost.

(e) The item of Real Estate includes the site for the pumping station on the bank of the river north of Eighth Avenue (Lyons) and for the elevated tank on Olney Avenue. These prices have been estimated at the market price of property in that particular vicinity and allow for any buildings which would have to be removed. The prices for all machinery, tanks and boilers are taken from actual quotations from the manufacturers.

(f) Although the item of going value is one, upon which opinions differ, the courts and all engineering authorities agree that it is an element of value which must be taken into account. A plant which is in operation and earning money is obviously of more value than a similar plant which has been completed but has as yet no consumers. The going value is approximately the reasonable net earnings of the plant for the period during which the plant is acquiring its customers minus the earnings actually made during that time. In calculating this item we have assumed that it would require two years to establish the business on a complete working basis and also that during the first year of operation, the revenues would be one half of what they would be for an existing or old plant and that during the second year they would be

three-fourths of said revenue. There would be a saving in operating expenses during the first two years due to the saving in coal and other items of operation of approximately 11% amd 5% respectively. After considering the above factors, we have arrived at the sum of $49,050.00 as the value for the item of going value.

(g) Under the heading of working capital we have estimated the amount of cash which must be on hand at all times to carry on the business. As earnings must be allowed on this item we have deemed it only fair to include it in the estimate.

(h) The total valuation of the proposed plantsare as follows:

PLANT	VALUE	VALUE PER MILE OF MAINS	VALUE PER CAPITA	OPERATION & MAINTENANCE
"A"	$ 1,668,228.29	$22,800.00	$62.60	$ 37,000.00
"B"	1,314,707.17	18,000.00	49.40	29,560.00
"C"	1,455,327.04	26,200.00	55.00	37,000.00
"D"	1,107,719.60	19,750.00	41,50	29,560.00

8. OPERATION & MAINTENANCE.

The operation and maintenance of a water works system includes the care of the wells or if a river supply, the cost of purification system, care of the boilers and engines, the cleaning of mains, detection of leaks,

repairs of pipes, prevention of corrosion, provision against electrolysis, thawing of frozen pipes, care of valves, hydrants and meters and detection and prevention of waste.

The river supply with the necessary purification systems requires the constant attention of attendants who would not be needed in the case of the well supply. The following items give the detailed expense of operation and maintenance for the different plans.

PLANS "B" & "D".

WELL SUPPLY.

Superintendent	$2,400.00
Plant man	1,200.00
2 clerks	1,800.00
6 field men	5,400.00
2 engineers	2,160.00
2 firemen	1,800.00
City office	1,000.00
Insurance	800.00
Legal expense	200.00
Telephone and telegrams	200.00
Printing, stationery and postage	300.00
Automobile	800.00
Light, heat and janitor	400.00
Fuel	8,100.00
Oil	800.00
Maintenance, expenses, machinery, boilers, mains, etc.	2,000.00
Misc. items	200.00
TOTAL	$29,560.00

PLANS "A" & "C",

RIVER SUPPLY.

Superintendent	$2,400.00
Plant man	1,200.00
2 clerks	1,800.00
6 field men	5,400.00
2 engineers	2,160.00
2 firemen	1,800.00
City office	1,000.00
Insurance	800.00
Legal expense	200.00
Telephone and telegrams	200.00
Misc. items	200.00
Printing, stationery, postage, etc.	300.00
Automobile	800.00
Light, heat and janitor	400.00
Fuel	9,500;00
Oil	800.00
Maintenance, expense, machinery, boilers, mains, etc.	2,000.00
Sand for filter beds (2400 cu.yds.)	1,940.00
Labor	500.00
Coagulent	3,600.00
TOTAL	$37,000.00

9. FINANCIAL.

As the financial showing of a water works system is largely a question of book-keeping, it is very important that a proper and business like method of accounting be adopted; both as an aid in fixing the water rates and as a means of enlightening the public as to the exact financial condition of the water company or water department.

(a) Expense to be met.

The yearly expenses which must be met before the plant can be self sustaining are:

1. Interest on the bonded debt.
2. Operation and maintenance expenses.
3. Annual payment into the depreciation fund to provide for the renewal of the various parts of the system when worn out or otherwise rendered useless.

Other expenses optional with the City are:

4. Annual payment into a sinking fund to liquidate the bonded debt.
5. Annual cost of extensions and improvements.

Item No. 4 and 5 are not ordinarily included in the plant expenses unless the revenue from the sale of water is greater than expected. If we provide for both a depreciation fund and a sinking fund we would ve virtually taxing the present generation for the entire first cost of the works and for its renewal or its maintenance in perfect condtion. This arrangement is much too liberal toward the future generation and should not be adopted unless the city finances are in good condition. Generally the sinking fund receives the most and often the

only consideration and in some states such a fund is required by law. If the sinking fund be adjusted to pay the bonds at the end of a period corresponding to the life of the plant as a whole, or for safety a little before this time, then the sinking fund is equivalent to a fund for depreciation. If a sinking fund is not provided, then a depreciation fund is necessary. This should be sufficient to furnish funds for the renewal or replacement of old parts and as a factor of safety in calculating the payments into this fund, the more permanent portions of the plant should be assumed to have a limted life. Thus it often happens that a portion of the depreciation fund can be used to gradually extinguish a part of the bonded debt. The cost of extensions should be met in the same way as the cost of the new works that is, by issuing bonds and at the same time providing a corresponding increase in the sinking or depreciation fund. In the case of a municipal plant the item of profit should be omitted as a city could not expect a gain in revenue from supplying itself with water. If more is paid into the treasury than is sufficient to meet all expenses, it can only be considered as a sort of indirect tax levied for other purposes.

The water department should not be expected to bear a portion of the general expense of the city. From these considerations it is evident that the annual expense of a water works system must include the interest on the bonded debt, the operation and maintenance expense including ordinary repairs and a payment into a sinking fund or depreciation fund. The annual expense for the four different plans are:-

PLANT	INT. ON 1ST COST.	OPERATION & MAINTENANCE	DEPRECIATION	TOTAL ANNUAL EXPENSE.
"A"	$66,792.13	$37,000.00	$ 6,603.01	$110,332.14
"B"	52,588.29	29,560.00	5,682.36	87,830.64
"C"	58,213.08	37,000.00	5,737.35	100,950.43
"D"	44,308.78	29,560.00	4,818.03	78,686.81

(b) RELATIVE COST OF DIFFERENT SERVICES.

A waterworks system furnishes water first, for private use, second, for public use on streets, flushing sewers, fountains and public buildings and third for fire protection to property. The cost of water used for private and public use as heretofore set forth in 1 and 2 may be considered as the approximate proportion to quantities of water supplied but in the case of fire protection it is all out of proportion to the amount of water used. The reason for this is the cost of construction is greatly affected by the fact that we must provide for the future,

while the amount of water consumed by fire protection is very slight. The cost involved in furnishing adequate fire protection is due to increased pumping capacity required, increase in size of mains, reservoir or stand pipes, cost of hydrants and the correspondingly cost of operation and maintenance. Another very considerable part of the cost which is not directly chargeable to the present consumers of water is the provision for future growth. Of the first cost, easily 1/3 may be charged to the cost of fire protection. For the purpose of arriving at the relative cost of services rendered we have divided the cost into two parts that which may be charged to the fire protection only and that which may be charged to all water consumers both private and public. We have made an analysis of Plan "D" with repsect to these two services with the results as shown by the following table.

APPORTIONMENT OF COST BETWEEN PUBLIC, PRIVATE AND FIRE PROTECTION.

ITEM	TOTAL NET VALUE	CONSUMPTION %	CONSUMPTION AMOUNT	FIRE PROTECTION %	FIRE PROTECTION AMOUNT
1-7	$575,793.62	55	$316,686.49	45	$259,107.13
8	13,932.00	0		100	13,932.00
9-10	149,827.20	80	119,861.76	20	29,965.44
11	53,000.00	50	26,500.00	50	26,500.00
12	12,000.00	80	9,600.00	20	2,400.00

13	9,000.00	80	7,200.00	20	1,800.00
14	30,150.00	55	16,582.50	45	13,567.50
15	1,500.00	55	825.00	45	675.00
16-17	16,272.00	60	9,763.20	40	6,508.80
18-20	41,730.00	55	22,951.50	45	18,778.50
21	3,000.00	75	2,250.00	25	750.00
22	1,800.00	55	990.00	45	810.00
23-26	199,814.78	75	149,861.09	25	49,953.69
	$1,107,719.60	62%	$683,071.54	38%	$424,648.06

It may be seen from this analysis that 38% may be charged to fire protection and 62% to all water consumers.

(c) SOURCES OF REVENUE.

The sources of revenue are water rates and funds received by general taxation. Funds received from taxation are levied upon all property while the revenue from water rates is proportionable to the amount of water used. It is only natural that the cost of furnishing water to consumers should be paid according to the amount used and that the cost of supply of water for fire protection should be paid by taxation. The expense of providing for the future should also be met by the city as a whole. The proportion of revenue from each source depends very much upon local conditions, size of the city and the shape of the distributing system, character of supply, etc. In a city such as Clinton the distributing system, being long and irregular is more expensive than one in a compact

city whose boundaries are more nearly square.

(d) WATER RATES.

In fixing the rates for any waterworks system allowance must be made for the fact that quite a large amount of water at the pumping station can not be accounted for and the rate per unit of volume must be correspondingly raised. In fairness to all consumers of water both pirvate and public and also the water department all consumers including the municipality itself should be provided with meters and should pay according to the amount of water used.

The estimated receipts from the various classes of users in any water works system may be closely estimated so as to provide for the annual expense, as heretofore stated. The City's share of the expense for Plan "D" should be 38% of the total annual expense of $78,686.81 or approximately $29,900.00. If we then assume the out put charge per 1,000 gallons as shown on Plate 5, the receipts would be $65,286.00 plus $15,600.00 a four mill levy as the city's share or $80,886.00. This would leave us a surplus of over $2,000.00 as a factor of safety.

You have the power under the law to levy a five mill tax and a two mill sinking fund tax, in all seven mills which at $3,900.00 would net $27,300.00 If you care to levy the full seven mills you could reduce the meter rates a corresponding amount.

The number of gallons sold yearly has been carefully apportioned to the different classes of users, the total amounting to 49.75 gallons per capita per day. For plan "A", "B" and "C" the water rates or the tax levy would have to be raised in proportion to the total annual expense.

ANNUAL EXPENSE.

Plan A $110,332.14 - 1.40% rate for Plan D - 35¢ to 8.4¢
Plan B 87,830.64 - 1.12% rate for Plan D - 28¢ to 6.7¢
Plan C 100,950.43 - 1.28% rate for Plan D - 32¢ to 7.7¢

The difference in annual expense for the different plans is caused by the cost of the system and also the increased expense in operation and maintenance. The proposed rates per 1,000 gallons is very clearly shown on Plate 12. You will note on this diagram that the proposed rates for Clinton which are shown by the heavy lines are somewhat lower than the old rates for the small consumer while it is somewhat higher for the intermediate con-

consumer from 15,000 to 1,000,000 gallons per month. The rate for the consumers over 1,000,000 gallons is the same as the present rates. The cost of the first 1,000,000 gallons according to the proposed rates would be $112.20.

Many authorities in analyzing the cost of service to consumers for water divide the cost into two distinct elements, namely readiness-to-serve cost and the out put cost. The first includes the cost of the meter department, including the reading of meters, book keeping and a certain portion of the expense in maintaining large pipes, connections and pumps which are necessary to supply the maximum amount of water. This service cost would be approximately a fixed amount for all demestic consumers but would be larger for large consumers, chiefly on account of the cost of meters and the higher demand. Consumers who require special private fire protection would also be balled upon to pay a higher service cost. The minimum cost of service as reported by the Wisconsin Railroad Commission was placed at $3.00 per year for 5/8" connections and $20.00 per year for four inch meters, therefor the minimum rate of $3.00 and the maximum rate of $20.00 would seem to be reasonable and equitable.

The second element of cost, the out put cost is dependent upon the amount of water furnished, the large consumer being charged a smaller amount per gallon than the smaller consumer. The service to the larger consumers in a sense is competitive as the larger consumer will not hestitate to furnish his own supply if he can do so at a less expense than it costs him to buy from the water department. If the schedule of rates be adopted with the service charge included, the corresponding rates per 1,000 gallons will have to be reduced.

10. SUMMARY.

We have prepared plans for and shown the cost of four alternate systems comprising both the river and well supply with complete distribution systems and partial distribution systems. We have also shown the total annual cost and schedule of rates which will be required to operate the waterworks system under the above conditions. Due to the fact that we are planning to build a system of waterworks in a city which is already built up the total cost of the proposed plans may seem large but we should bear in mind that the annual expense is the item upon which we must base all our calculations. Voting bonds for

a revenue paying utility like a waterworks plant, unlike sewers or paving, does not increase the city's indebtedness but merely acta similarly to placing a mortgage on the plant itself.

The analysis of costs and rates show conclusively that the City can construct and operate a new plant which will be efficient and practicable and that the rates to the consumer and the water tax levy will not be excessive. This report shows the maximum domestic rate to be twenty-five (25) cents per 1,000 gallons, minimum six ($6.00) dollars per year, and the tax levy to be four (4) mills. With the sale of more water and the increase of the valuation of taxable property, the water rates and the water tax can be lowered or the excess applied to retire some of the outstanding bonds against the plant.

As there are many advocates of municipal ownership and also private ownership in the City, I recommend that the conditions as above outlined shall be plainly presented to the public and an election held to determine our course for future action.

DETAILED SUMMARY OF THE COST OF THE PROPOSED WATERWORKS SYSTEM.

A. RIVER WATER SUPPLY.

73 miles of mains
758 hydrants

ITEM NO.	DESCRIPTION	TOTAL
1.	Mains	$423,796.45
2.	Laying mains	186,099.60
3.	Rock excavation	37,500.00
4.	Pavement over mains	36,429.60
5.	Railroad crossings	1,280.00
6.	Sewer,creeks and crossings	500.00
7.	Valves	8,825.60
8.	Hydrants	21,224.00
9.	House connections	142,607.00
10.	Meters	62,990.20
11.	Tank	53,000.00
12.	Real estate	12,000.00
13.	Pumping station	8,949.76
14.	Intake pumps	9,000.00
15.	Main pumps	30,150.00
16.	Piping in pump house	1,500.00
17.	Boilers	12,000.00
18.	Chimney	4,272.00
19.	Drain water pump	600.00
20.	Intake	27,449.20
21.	Settling basins	115,000.00
22.	Filter beds	111,100.00
23.	Reservoir	11,730.00
24.	Pipes - station ground	21,290.64
25.	Furniture	3,000.00
26.	Excavation and filling	47,170.00
27.	Going value	48,150.00
28.	Engineering & superintendence	111,157.12
29.	Interest during construction	111,157.12
30.	Working capital	8,300.00

ITEMIZED ESTIMATE OF COST OF WATERWORKS SYSTEM.

A. RIVER WATER SUPPLY.

73 miles of mains
758 hydrants

ITEM NO. 1 - STREETS MAINS.

11,929.5	tons cast iron pipe	@	$33.40	$398,445.30
15,625	lbs. oakum	@	.09	1,406.25
49,298	lbs. lead	@	.05	2,464.90
298	tons specials	@	60.00	17,880.00
9,000	ton miles (hauling)			3,600.00
	TOTAL			$423,796.45

ITEM NO. 2 - LAYING PIPE.

480	lin.ft.	30-inch pipe	@	1.30	$ 624.00
16,460	lin.ft.	24-inch pipe	@	1.14	18,764.40
3,700	lin.ft.	20-inch pipe	@	1.08	3,996.00
6,800	lin.ft.	18-inch pipe	@	1.05	7,140.00
14,390	lin.ft.	16-inch pipe	@	.78	11,224.20
14,140	lin.ft.	14-inch pipe	@	.67	9,473.80
30,720	lin.ft.	12-inch pipe	@	.58	17,817.60
16,020	lin.ft.	10-inch pipe	@	.49	7,849.80
44,700	lin.ft.	8-inch pipe	@	.41	18,327.00
108,260	lin.ft.	6-inch pipe	@	.37	40,056.20
138,960	lin.ft.	4-inch pipe	@	.33	45,823.80
15,160	lin.ft.	4-inch hyd."	@	.33	5,002.80
		TOTAL			$186,099.60

ITEM NO. 3 - ROCK EXCAVATION.

Present system - 30,180 lin. ft. - average depth 2.50 feet equals 7,000 cu. yds.

Bluff Road	12,420 lin.ft.
9th St. Lyons	3,200 lin.ft.
8th Ave. Lyons	1,840 lin.ft.
	17,460 lin.ft.

17,460 lin.ft. - 2.5' av. depth, 3' wide =	5,658.3 cu.yds.
Present system..............................	7,000.0 " "
Extra.......................................	2,341.7 " "
	15,000.0 cu.yds.

15,000 cu. yds. rock excavation	@ $ 2.50	$ 37,500.00

ITEM NO. 4 - PAVEMENT OVER MAINS & HOUSE CONNECTIONS
(Note: trenching thru and replacing.)

MAINS - WIDTH OF PAVING THREE FEET.

Wood block paving	922 sq. yds.
Brick paving	9,490 " "
Concrete paving	2,862 " "
Old brick paving	15,317 " "
	28,591 sq. yds.

CONNECTIONS - WIDTH OF PAVING THREE FEET.

Wood block paving..................	57 connections
Concrete paving	276 "
Vitrified block	808 "
Old brick paving	1,114 "
TOTAL AMOUNT OF PAVING REPLACED	371 sq. yds.

COST OF CUTTING THROUGH PAVEMENTS AND REPLACING THEM AT $2.00 PER CU. YD.

	CUTTING	REPLACING	TOTAL
Wood block	.80	1.30	$ 2.10
Vitrified block	.80	1.39	2.10
Concrete	.42	1.38	1.80
Old brick	.09	.51	.60

GRAND TOTAL

Wood block paving	922 sq. yds.	@ 2.10	$ 1,936.20
Vitrified block	9,490 sq. yds.	@ 2.10	19,929.00
Concrete paving	2,862 sq. yds.	@ 1.80	5,151.60
Old brick paving	15,688 sq. yds.	@ .60	9,412.80
			$ 36,429.60

ITEM NO. 5 - RAILROAD CROSSINGS.

(A) Railroad crossings; 2,037 lin. ft.	@ $ .50	$ 1,018.50
(B) Street railroad crossings: 653.75 lin.ft.	@ $ .40	261.50
	TOTAL	$ 1,280.00

ITEM NO. 6 - SEWERS, CULVERTS AND CREEK CROSSINGS.

10 crossings	@ $50.00	$ 500.00

ITEM NO. 7 - VALVES, VALVE BOXES, ETC.

7 - 24 inch valves.......	@ 175.00	$ 1,125.00
1 - 20 inch valve	@ 113.00	113.00
3 - 18 inch valves.......	@ 93.00	279.00
7 - 16 inch valves.......	@ 70.00	490.00
10 - 14 inch valves.......	@ 60.00	600.00
21 - 12 inch valves.......	@ 38.00	798.00
25 - 10 inch valves.......	@ 30.00	750.00
31 - 8 inch valves.......	@ 20.80	644.80
168 - 6 inch valves.......	@ 14.00	2,352.00
183 - 4 inch valves.......	@ 8.60	1,573.80
	TOTAL	$ 8,825.60

ITEM NO. 8 - FIRE HYDRANTS.

758 hydrants	@ 28.00	$ 21,224.00

ITEM NO. 9 - HOUSE CONNECTIONS

5,953 - 5/8" connec. 20' long	@ 23.00	$126,919.00
237 - 3/4" connec. 20' long	@ 24.00	5,688.00
	TOTAL	$142,607.00

ITEM NO. 10 - METERS.

5,953 meters - 5/8"	@ 10.00	$ 59,530.00
237 meters - 3/4"	@ 14.60	36,460.20
	TOTAL	$ 62,990.20

ITEM NO. 11 - ELEVATED TANK.

Tank	$48,000.00	
Foundation	5,000.00	$ 53,000.00

ITEM NO. 12 - REAL ESTATE.

Waterworks site in Lyons Elevated tank site Olney Avenue	$ 12,000.00

ITEM NO. 13 - PUMPING STATION.

6,992 sq. ft. (area of building) @ 1.28	$ 8,949.76

ITEM NO. 14 - INTAKE PUMPS.

2 - 3 1/2 million gallon pumps	$ 6,300.00
Freight from Dayton Ohio to Clinton 66,000 lbs. @ 25.2¢ per 100	166.32
Foundation	1,000.00
2 - steam engines	1,000.00
Freight on engines	100.00
Foundation	433.68
	$ 9,000.00

ITEM NO. 15 - HIGH PRESSURE PUMPS.

1 - 2 1/2 million gallon pump	$ 10,626.00
Freight	176.40
Foundation	494.60
	$ 11,300.00
2 - pumps	$ 22,600.00
1 1 1/2 million gallon pump	$ 7,000.00
Freight	150.00
Foundation	400.00
	$ 7,550.00

GRAND TOTAL

2 - 2 1/2 million gallon pumps	$ 22,600.00
1 - 1 1/2 million gallon pump	7,550.00
	$ 30,150.00

ITEM NO. 16 - PIPING IN PUMPING STATION			$ 1,500.00
ITEM NO. 17 - BOILER PLANT			
4 boilers	$ 8,000.00		
Brick work	4,000.00		$ 12,000.00
ITEM NO. 18 - CHIMNEY.			
89 feet		@ $ 48.00	$ 4,272.00
ITEM NO. 19 - DRAIN WATER PUMP.			$ 600.00
ITEM NO. 20 - INTAKE Total length 350'			
SHEETING.			
45 M. B. ft		@ $ 30.00	$ 1,350.00
EXCAVATION			
1,500 cu. yds. rock		@ 3.00	4,500.00
720 cu. yds. earth		@ .50	360.00
CONCRETE PIPE			
330 lin.ft. - 48" concrete pipe		@ 5.00	1,650.00
Labor of laying and dumping			1,650.00
COFFER DAM			
516 cu. yds. (Note 220 feet long)		@ 3.00	1,548.00
EXCAVATION UNDER C. I. PIPE			
200 cu. yds.		@ 12.00	2,400.00
CAST IRON PIPE			
95 tons of 48" pipe		@ 33.40	3,173.00
Labor placing pipe			3,022.70
BACKFILLING ON TOP OF C. I. PIPE			
800 cu. yds. stone		@ 1.50	1,200.00

CRIB

80 cu. yds. concrete	@ 7.00	$ 560.00
Timber - 45 M. B. ft	@30.00	1,350.00
Crushed rock 220 cu. yds.	@ 1.50	330.00
Placing		2,243.00

PUMP WELL

465 cu. yds.	@ .50	$ 232.50
115 cu. yds. concrete	@12.00	1,380.00
Drain manhole - pumping		500.00
	GRAND TOTAL	$27,449.20

ITEM NO. 21 - SETTING BASINS.

2,123 cu. yds. concrete	@12.00	$ 25,476.00
279,056 lbs. reinforcing bars	@ .04	11,162.24
		$ 36,638.24
3 tanks as outlined		$109,914.72
Operating house		5,085.28
	TOTAL	$115,000.00

ITEM NO. 22 - FILTER BEDS.

621,400 lbs reinforcing bars	@ .04	$ 24,856.00
5,045 cu. yds. concrete	@12.00	60,540.00
33,000 sq. ft. concrete floor	@ .12	3,960.00
1,833 cu. yds. clay puddle	@ .75	1,374.75
6,844 cu. yds. broken stone	@ 1.50	10,266.00
7,333 cu. yds. sand	@ 1.00	7,333.00
18 vents	@10.00	180.00
3 houses		1,204.25
165 lin.ft. 24" pipe	@ 1.00	165.00
60 lin.ft. 20" pipe	@ .75	45.00
120 lin.ft. 18" pipe	@ .65	78.00
120 lin.ft. 15" pipe	@ .50	60.00
120 lin.ft. 12" pipe	@ .40	48.00
3,300 lin.ft. 6" pipe	@ .30	990.00
	TOTAL	$111,100.00

ITEM NO. 23 - RESERVOIR.

805	cu. yds. concrete	@ 12.00	$ 9,660.00
48,160	lbs. reinforcing bars	@ .04	1,926.40
4,120	sq. ft. triangular Mesh No. 34	@ .03	123.60
1	door	@ 10.00	10.00
2	windows	@ 5.00	10.00
		TOTAL	$ 11,730.00

ITEM NO. 24 - PIPING

310	tons of 24" c.i. pipe	@ 33.40	$ 10,354.00
2,236	lin.ft. laying	@ 1.14	2,548.04
1,515	lin.ft. 24" drain pipe	@ 1.00	1,515.00
	Valves		5,911.00
14.6	tons rails .		627.80
350	ties 6" x 8" x 8'	@ .85	297.50
	Laying track 1,110'		37.30
		TOTAL	$ 21,290.64

ITEM NO. 25 - FURNITURE, TOOLS ETC. $ 3,000.00

ITEM NO. 26 - EXCAVATION & FILLING

TOTAL EXCAVATION		TOTAL FILLING	
Reservoir	1,265 cu. yds.	Filter beds	22,448 cu.yds.
Filter beds	1,763 cu. yds.	Tank No. 2	2,200 cu.yds.
Tank No. 1	860 cu. yds.	Tank No. 3	2,200 cu.yds.
Pumping station	930 cu. yds.	Sta. grading	53,152 cu.yds.
Well	782 cu. yds.		
	5,600 cu. yds.		80,000 cu.yds.

1,270	cu.yds. rock excavation	@ $ 3.00	$ 3,810.00
5,600	cu. yds. earth "	@ .60	3,360.00
80,000	cu. yds. filling	@ .50	40,000.00
		TOTAL	$ 47,170.00

ITEM NO. 27 - GOING VALUE

YEAR	REVENUE	LOSS FOR NEW PLANT	SAVINGS IN OPER. EXP.	NET LOSS OR GOING VALUE
1917	$71,300.00	$35,650.00	$3,800.00	$31,850.00
1918	72,700.00	18,200.00	1,900.00	16,300.00
				$48,150.00

ITEM NO. 28 - ENGINEERING AND SUPERINTENDENCE	$111,157.12
ITEM NO. 29 - INTEREST DURING CONSTRUCTION	$111,157.12
ITEM NO. 30 - WORKING CAPITAL	$ 8,300.00

DETAILED SUMMARY OF THE COST OF THE PROPOSED WATERWORKS SYSTEM.

P. **WELL SUPPLY.**

73 miles of mains.
758 hydrants.

ITEM NO.	DESCRIPTION	TOTAL
1.	Street mains	$423,790.45
2.	Laying mains	186,099.60
3.	Rock excavation	37,500.00
4.	Pavement over mains	36,429.60
5.	Railroad crossings	1,280.00
6.	Sewers, creeks & crossings	500.00
7.	Valves	8,825.60
8.	Hydrants	21,224.00
9.	House connections	142,607.00
10.	Meters	62,990.20
11.	Tank	53,000.00
12.	Real Estate	12,000.00
13.	Pumping station	4,000.00
14.	Main pumps	30,150.00
15.	Piping in pump house	1,500.00
16.	Boilers	12,000.00
17.	Chimney	4,272.00
18.	Wells	20,000.00
19.	Reservoir	11,730.00
20.	Pipes - station ground	10,000.00
21.	Furniture	3,000.00
22.	Excavation and filling	1,800.00
23.	Going value	48,150.00
24.	Engineering & Superintendence	86,776.36
25.	Interest during construction	86,776.36
26.	Working capital	8,300.00

ITEMIZED ESTIMATE OF COST OF WATERWORKS SYSTEM.

B. WELL SUPPLY.

73 miles of mains
758 hydrants.

ITEM NO. 1 - STREET MAINS.

11,929.5	tons cast iron pipe	@ 33.40	$398,445.30
15,625	lbs. oakum	@ .09	1,406.25
49,298	lbs. lead	@ .05	2,464.90
298	tons specials	@ 60.00	17,880.00
9,000	tons miles (hauling)		3,600.00
		TOTAL	$423,796.45

ITEM NO. 2 - LAYING PIPE.

480	lin.ft. 30-inch pipe	@ 1.30	$ 624.00
16,460	lin.ft. 24-inch pipe	@ 1.14	18,764.40
3,700	lin.ft. 20-inch pipe	@ 1.08	3,996.00
6,800	lin.ft. 18-inch pipe	@ 1.05	7,140.00
14,390	lin.ft. 16-inch pipe	@ .78	11,224.20
14,140	lin.ft. 14-inch pipe	@ .67	9,473.80
30,720	lin.ft. 12-inch pipe	@ .58	17,817.60
16,020	lin.ft. 10-inch pipe	@ .49	7,849.80
44,700	lin.ft. 8-inch pipe	@ .41	18,327.00
108,260	lin.ft. 6-inch pipe	@ .37	40,056.20
138,960	lin.ft. 4-inch pipe	@ .33	45,823.80
15,160	lin.ft. 4-inch hydr. pipe	@ .33	5,002.80
		TOTAL	$186,099.60

ITEM NO. 3 - ROCK EXCAVATION.

Present system - 30,180 lin. ft. - average depth 2.5 ft. equals 7,000 cu. yds.

Bluff Road	12,420 lin.ft.
9th St. Lyons	3,200 " "
8th Ave. Lyons	1,840 " "
	17,460 lin.ft.

17,460 lin.ft. - 2.5' av. depth, 3' wide =	5658.3 cu.yds.
Present system........................	7000.0 " "
Extra.................................	2341.7 " "
	15000.0 cu.yds.

15,000 cu. yds. rock excavation @ $ 2.50 $ 37,500.00

ITEM NO. 4 - PAVEMENTS OVER MAINS & HOUSE CONNECTIONS. (NOTE: TRENCHING THRU AND REPLACING)

MAINS - WIDTH OF PAVING THREE FEET.

Wood block paving	922 sq. yds.
Brick paving	9,490 " "
Concrete paving	2,862 " "
Old brick paving	15,317 " "
	28,591 sq. yds.

CONNECTIONS - WIDTH OF PAVING THREE FEET.

Wood block paving	57 connections
Concrete paving	276 "
Vitrified block paving..................	808 "
Old brick paving	1,114 "
TOTAL AMOUNT OF PAVING REPLACED	371 sq. yds.

COST OF CUTTING THRU PAVEMENTS, AND REPLACING THEM AT $2.00 PER CU.YD.

	CUTTING	REPLACING	TOTAL
Wood block	.80	1.30	$ 2.10
Vitrified block	.80	1.30	2.10
Concrete	.42	1.38	1.80
Old brick	.09	.51	.60

GRAND TOTAL

Wood block paving	922 sq.yds.	@ 2.10	$ 1,936.20
Vitrified block	9,490 " "	@ 2.10	19,929.00
Concrete paving	2,862 " "	@ 1.80	5,151.60
Old brick paving	15,688 " "	@ .60	9,412.80
			$ 36,429.60

ITEM NO. 5 - RAILROAD CROSSINGS.

(A) Railroad crossings; 2,037 lin.ft.	@ .50	$ 1,018.50
(B) Street Railroad crossings: 653.75 lin.ft.	@ .40	261.50
TOTAL		$ 1,280.00

ITEM NO. 6 - SEWERS, CULVERTS & CREEK CROSSINGS.

10 crossings	@50.00	$ 500.00

ITEM NO. 7 - VALVES, VALVE BOXES, ETC.

7 - 24-inch valves	@ 175.00	$ 1,225.00
1 - 20-inch valve	@ 113.00	113.00
3 - 18-inch valves	@ 93.00	279.00
7 - 16-inch valves	@ 70.00	490.00
10 - 14-inch valves	@ 60.00	600.00
21 - 12-inch valves	@ 38.00	798.00
25 - 10-inch valves	@ 30.00	750.00
31 - 8-inch valves	@ 20.80	644.80
168 - 6-inch valves	@ 14.00	2,352.00
183 - 4-inch valves	@ 8.60	1,573.80
TOTAL		$ 8,825.60

ITEM NO. 8 - FIRE HYDRANTS.

758 hydrants	@ 28.00	$ 21,224.00

ITEM NO. 9 - HOUSE CONNECTIONS.

5,953 - 5/8" connec. (20' long)	@ 23.00	$136,919.00
237 - 3/4" connec. (20' long)	@ 24.00	5,688.00
TOTAL		$142,607.00

ITEM NO. 10 - METERS.

5,953 - 5/8" meters	@ 10.00	$ 59,530.00
237 - 3/4" meters	@ 14.60	3,460.20
TOTAL		$ 62,990.20

ITEM NO. 11 - ELEVATED TANK.

Tank	$ 48,000.00	
Foundation	5,000.00	$ 53,000.00

ITEM NO. 12 - REAL ESTATE.

Waterworks site in Lyons Elevated tank site on Olney Avenue	$ 12,000.00

ITEM NO. 13 - PUMPING STATION.

3,125 sq. ft. area of building @ 1.28	$ 4,000.00

ITEM NO. 14 - MAIN PUMPS.

1 - 2 1/2 million gallon pump	$ 10,625.00
Freight	176.40
Foundation	497.60
	$ 11,300.00
2 - pumps	$ 22,600.00
1 - 1 1/2 million gallon pump	$ 7,000.00
Freight	150.00
Foundation	400.00
	$ 7,550.00

GRAND TOTAL

2 - 2 1/2 million gallon pumps	$ 22,600.00
1 - 1 1/2 million gallon pump	7,550.00
TOTAL	$ 30,150.00

ITEM NO. 15 - PIPING IN PUMP HOUSE. $ 1,500.00

ITEM NO. 16 - BOILERS.

4 boilers	$ 8,000.00	
Brick work	4,000.00	$ 12,000.00

ITEM NO. 17 - CHIMNEY.

89	feet	@ 48.00	$ 4,272.00

ITEM NO. 18 - WELLS - Complete

$ 20,000.00

ITEM NO. 19 - RESERVOIR

805	cu. yds. concrete	@ 12.00	$ 9,660.00
48,160	lbs. reinforcing bars	@ .04	1,926.40
4,120	sq.ft. tri. mesh No.34	@ .03	123.60
1	door	@ 10.00	10.00
2	windows	@ 5.00	10.00
		TOTAL	$ 11,730.00

ITEM NO. 20 - PIPES IN STATION GROUND.

24	tons of 12" c.i. pipe	@ 33.40	$ 801.60
	Labor for same		650.00
1,444.8	cu. yds. rock exca.	@ 3.00	4,334.40
	Pumping M. H.		1,612.00
8.4	tons of 24" c.i. pipe	@ 33.40	280.56
5	tons of 12" c.i. pipe	@ 33 40	167.00
420	lin.ft. 24" vit. pipe	@ 1.00	420.00
710	lin. c.i. pipe laid	@ 1.14	809.44
	Outlet - extra		400.00
3 -	24 inch valves	@175.00	525.00
		TOTAL	$ 10,000.00

ITEM NO. 21 - FURNITURE, TOOLS, ETC.

$ 3,000.00

ITEM NO. 22 - EXCAVATION AND FILLING.

2,530	cu. yds. earth excavation	@ .60	$ 1,518.00
564	cu. yds. filling	@ .50	282.00
			$ 1,800.00

ITEM NO. 23 - GOING VALUE.

YEAR	REVENUE	LOSS FOR NEW PLANT	SAVINGS IN OPER. EXP.	NET LOSS OR GOING VALUE
1917	$71,300.00	$35,650.00	$ 3,800.00	$ 31,850.00
1918	72,700.00	18,200.00	1,900.00	16,300.00
				$ 48,150.00

ITEM NO. 24 - ENGINEERING & SUPERINTENDENCE $ 86,776.36

ITEM NO. 25 - INTEREST DURING CONSTRUCTION $ 86,776.36

ITEM NO. 26 - WORKING CAPITAL $ 8,300.00

DETAILED SUMMARY OF THE COST OF THE PROPOSED WATERWORKS SYSTEM.

C. RIVER WATER SUPPLY.

56 miles of mains
494 hydrants.

ITEM NO.	DESCRIPTION	TOTAL
1.	Mains	$346,789.00
2.	Laying mains	145,999.42
3.	Rock excavation	37,500.00
4.	Pavement over mains	36,429.60
5.	Railroad crossings	1,280.00
6.	Sewer, culverts & creek crossings	500.00
7.	Valves	7,295.60
8.	Hydrants	13,832.00
9.	House connections	103,737.00
10.	Meters	46,090.20
11.	Tank	53,000.00
12.	Real estate	12,000.00
13.	Pumping station	9,000.00
14.	Intake pumps	9,000.00
15.	Main pumps	30,150.00
16.	Piping in pump house	1,500.00
17.	Boilers	12,000.00
18.	Chimney	4,272.00
19.	Drain water pump	600.00
20.	Intake	27,300.00
21.	Settling basins	115,000.00
22.	Filter beds	111,100.00
23.	Reservoir	11,730.00
24.	Pipes - station grounds	21,291.60
25.	Furniture, tools, etc.	3,000.00
26.	Excavation and filling	47,170.00
27.	Going value	49,050.00
28.	Engineering & Superintendence	96,605.31
29.	Interest during construction	96,605.31
30.	Working capital	5,500.00

ITEMIZED ESTIMATE OF COST OF WATERWORKS SYSTEM.

C. RIVER WATER SUPPLY.

56 miles of mains
494 hydrants.

ITEM NO. 1 - STREET MAINS.

9,846.1	tons cast iron pipe	@ 33.40	$328,859.74
246	tons specials	@ 60.00	14,760.00
12,555	lbs. oakum	@ .09	1,129.95
38,844	lbs. lead	@ .05 1/4	2,039.31
		TOTAL	$346,789.00

ITEM NO. 2 - LAYING MAINS.

480	lin.ft.	30-inch pipe	@ 1.31	$ 628.80
16,460	lin.ft.	24-inch pipe	@ 1.14	18,764.40
3,700	lin.ft.	20-inch pipe	@ 1.08	3,996.00
6,800	lin.ft.	18-inch pipe	@ 1.05	7,140.00
14,390	lin.ft.	16-inch pipe	@ .78	11,224.20
14,140	lin.ft.	14-inch pipe	@ .67	9,473.80
23,380	lin.ft.	12-inch pipe	@ .58	13,560.40
11,390	lin.ft.	10-inch pipe	@ .49	5,581.10
25,300	lin.ft.	8-inch pipe	@ .41	10,373.00
69,916	lin.ft.	6-inch pipe	@ .37	25,868.92
109,480	lin.ft.	4-inch pipe	@ .33	36,128.40
9,880	lin.ft.	4-inch hydr.pipe	@ .33	3,260.40
			TOTAL	$145,999.42

ITEM NO. 3 - ROCK EXCAVATION.

Present system - 30,180 lin.ft. - average depth 2.50 feet equals 7,000 cu. yds.

Bluff Road	12,420 lin.ft.
9th St. Lyons	3,200 lin.ft.
8th Ave. Lyons.......................	1,840 lin.ft.
	17,460 lin.ft.

17,460 lin.ft.-2.5' av.depth-3'wide =	5,658.3 cu.yds.
Present system	7,000. " "
Extra	2,341.7 " "
	15,000.0 cu. yds.

15,000 cu. yds. rock excavation @ $ 2.50 $37,500.00

ITEM NO. 4 - PAVEMENTS, WATER MAINS & HOUSE CONNECTIONS.

(Note: trenching thru and replacing)

MAINS - WIDTH OF PAVING THREE FEET.

Wood block	922 sq.yds.
Brick	9,490 " "
Concrete	2,862 " "
Old brick	15,317 " "
	28,591 sq.yds.

CONNECTIONS - WIDTH OF PAVING THREE FEET.

Wood block	57 connections
Concrete	276 "
Vitrified block	808 "
Old brick	1114 "
TOTAL AMOUNT OF PAVING REPLACED	371 sq. yds.

COST OF CUTTING THROUGH PAVEMENTS, AND REPLACING THEM AT $2.00 PER CU.YD.

	CUTTING	REPLACING	TOTAL
Wood block	.80.	1.30	$2.10
Vit. block	.80	1.30	2.10
Concrete	.42	1.38	1.80
Old brick	.09	.51	.60

GRAND TOTAL

Wood block paving	922 sq.yds.	@ $2.10	$ 1,936.20
Vitrified block	9,490 " "	@ 2.10	19,929.00
Concrete paving	2,862 " "	@ 1.80	5,151.60
Old brick paving	15,688 " "	@ .60	9,412.80
			$36,429.60

ITEM NO. 5 - RAILROAD CROSSINGS.

(a) Railroad crossings: 2,037 lin. ft.	@ .50	$ 1,018.50
(b) Street railroad crossings: 653.75 lin. ft.	@ .40	261.50
	TOTAL	$ 1,280.00

ITEM NO. 6 - SEWER, CULVERT & CREEK CROSSINGS.

10 crossings	@ 50.00	$ 500.00

ITEM NO. 7 - VALVES.

7 - 24-inch valves	@175.00	$ 1,225.00
1 - 20-inch valve	@113.00	113.00
2 - 18-inch valves	@ 93.00	186.00
7 - 16-inch valves	@ 70.00	490.00
10 - 14-inch valves	@ 60.00	600.00
18 - 12-inch valves	@ 38.00	684.00
24 - 10-inch valves	@ 30.00	720.00
21 - 8-inch valves	@ 20.80	436.00
112 - 6-inch valves	@ 14.00	1,568.00
148 - 4-inch valves	@ 8.60	1,272.80
	TOTAL	$ 7,295.60

ITEM NO. 8 - FIRE HYDRANTS.

494 hydrants	@ 28.00	$13,832.00

ITEM NO. 9 - HOUSE CONNECTIONS.

4,263 - 5/8" connections	@ 23.00	$98,049.00
237 - 3/4" "	@ 24.00	5,688.00
	TOTAL	$103,737.00

ITEM NO. 10 - METERS.

4,263 - 5/8" meters	@ 10.00	$ 42,630.00
237 - 3/4" "	@ 14.60	3,460.20
	TOTAL	$ 46,090.20

ITEM NO. 11 - ELEVATED TANK.

Tank	$48,000.00	
Foundation	5,000.00	$ 53,000.00

ITEM NO. 12 - REAL ESTATE.

Waterworks site in Lyons Elevated tank site on Olney Avenue	$ 12,000.00

ITEM NO. 13 - PUMPING STATION.

6,992 sq. ft. (area of Building)	$ 9,000.00

ITEM NO. 14 - INTAKE PUMPS.

2 - 3 1/2 million gallon pumps	$ 6,300.00
Freight from Dayton, Ohio to Clinton: 66,000 lbs. 25.2¢ per 100#	166.32
Foundation	1,000.00
2 - steam engines	1,000.00
Freight on engines	100.00
Foundation	433.68
TOTAL	$ 9,000.00

ITEM NO. 15 - MAIN PUMPS.

1 - 2 1/2 million gallon pump	$ 10,626.00
Freight	176.40
Foundation	497.60
	$ 11,300.00
2 - pumps	$ 22,600.00
1 - 1 1/2 million gallon pump	$ 7,000.00
Freight	150 00
Foundation	400.00
	$ 7,550.00

GRAND TOTAL

2 - 2 1/2 million gallon pumps	$ 22,600.00
1 - 1 1/2 million gallon pump	7,550.00
	$ 30,150.00

ITEM NO. 16 - PIPING IN PUMP HOUSE		$ 1,500.00
ITEM NO. 17 - BOILER PLANT		
4 boilers	$ 8,000.00	
Brick work	4,000.00	$ 12,000.00
ITEM NO. 18 - CHIMNEY.		
89 feet	@ 48.00	$ 4,272.00
ITEM NO. 19 - DRAIN WATER PUMP		$ 600.00
ITEM NO. 20 INTAKE		
Total length 350 feet.		
SHEETING.		
45 M. B. ft	@ 30.60	$ 1,350.00
EXCAVATION.		
1,500 cu. yds. rock	@ 3.00	$ 4,500.00
720 cu. yds. earth	@ .50	360.00
CONCRETE PIPE.		
330 lin.ft. - 48" conc. pipe	@ 5.00	$ 1,650.00
Labor of laying and pumping		1,650.00
COFFER DAM.		
516 cu. yds. (Note: 220 feet long.)	@ .30	$ 154.80
EXCAVATION UNDER C. I. PIPE.		
200 cu. yds.	@ 12.00	$ 2,400.00
CAST IRON PIPE.		
95 tons of 48" pipe	@ 33.40	$ 3,173.00
Labor placing pipe		3,022.70

CRIB.

80	cu. yds. concrete	@ 7.00	$ 560.00
45	M.B.Ft. timber	@30.00	1,350.00
220	cu. yds. crushed rock		330.00
	Placing		2,243.00

BACKFILLING ON TOP OF C. I. PIPE.

800	cu. yds. stone	@ 1.50	$ 1,200.00

PUMP WELL

461. 2	cu. yds.	@ .50	$ 230.50
115	cu. yds. concrete	@12.00	1,380.00
	Drain manhole - pumping		$ 500.00
		TOTAL	$27,300.00

ITEM NO. 21 - SETTLING BASINS.

2,123	cu. yds. concrete	@12.00	$25,476.00
279,056	lbs. rein. bars	@ .04	11,162.24
		TOTAL	$36,638.24
3	tanks as above outlined		$109,914.72
	Operating house		5,085.28
		TOTAL	$115,000.00

ITEM NO. 22 - FILTER BEDS.

621,400	lbs. reinforcing bars	@ .04	$ 24,856.00
5,045	cu. yds. concrete	@12.00	60,540.00
33,000	sq.ft. concrete floor	@ .12	3,960.00
1,833	cu. yds. clay puddle	@ .75	1,374.75
6,844	cu. yds. broken stone	@ 1.50	10,266.00
7,333	cu. yds. sand	@ 1.00	7,333.00
18	vents	@10.00	180.00
3	houses		1,204.25
165	lin.ft. 24-inch pipe	@ 1.00	165.00

60 lin. ft. 20-inch pipe	@ .75	$ 45.00
120 lin. ft. 18-inch pipe	@ .65	78.00
120 lin. ft. 15-inch pipe	@ .50	60.00
120 lin. ft. 12-inch pipe	@ .40	48.00
3,300 lin. ft. 6-inch pipe	@ .30	990.00
	TOTAL	$111,100.00

ITEM NO. 23 - RESERVOIR.

805 cu. yds. concrete	@12.00	$ 9,660.00
48,160 lbs. rein. bars	@ .04	1,926.40
4,120 sq.ft. tri. mesh No.34	@ .03	123.60
1 door	@10.00	10.00
2 windows	@ 5.00	10.00
	TOTAL	$ 11,730.00

ITEM NO. 24 - PIPES - STATION GROUND.

310 tons 24" c.i. pipe	@33.40	$ 10,354.00
2,236 lin.ft. laying	@ 1.14	2,549.04
1,515 lin.ft.24" drain pipe	@ 1.00	1,515.00
Valves		5,911.00
14.6 tons of rails		627.80
350 ties 6" x 8" x 8'	@ .85	297.50
Laying track		37.30
	TOTAL	$ 21,291.60

ITEM NO. 25 - FURNITURE, TOOLS, ETC. $ 3,000.00

ITEM NO. 26 - EXCAVATION & FILLING.

TOTAL EXCAVATION		TOTAL FILLING	
Reservoir	1,265 cu. yds.	Filter beds	22,448 cu.yds.
Filter beds	1,763 " "	Tank No. 2	2,200 " "
Tank No. 1	860 " "	Tank No. 3	2,200 " "
Pump Station	930 " "	Sta grading	53,152 " "
Well	782 " "		
	5,600 cu; yds.		80,000 cu. yds.

1,270	cu.yds. rock excavation	@ 3.00	$ 3,810.00
5,600	cu.yds. earth excavation	@ .60	3,360.00
80,000	cu. yds. filling	@ .50	40,000.00
		TOTAL	$47,170.00

ITEM NO. 27 - GOING VALUE.

YEAR	REVENUE	LOSS FOR NEW PLANT	SAVINGS IN OPER. EXP.	NET LOSS OR GOING VALUE
1917	$71,300.00	$35,560.00	$ 3,000.00	$ 32,450.00
1918	72,700.00	18,200.00	1,600.00	16,600.00
				$ 49,050.00

ITEM NO. 28 - ENGINEERING & SUPERINTENDENCE $ 96,605.31

ITEM NO. 29 - INTEREST DURING CONSTRUCTION $ 96,605.31

ITEM NO. 30 - WORKING CAPITAL $ 5,500.00

DETAILED SUMMARY OF THE COST OF THE PROPOSED WATERWORKS SYSTEM.

D. WELL SUPPLY.

56 miles of mains
494 hydrants.

ITEM NO.	DESCRIPTION	TOTAL
1.	Street mains	$346,789.00
2.	Laying mains	145,999.42
3.	Rock excavation	37,500.00
4.	Pavements over mains	36,429.60
5.	Railroad crossings	1,280.00
6.	Sewer, culvert & creek crossings	500.00
7.	Valves	7,295.60
8.	Hydrants	13,832.00
9.	House connections	103,737.00
10.	Meters	46,090.20
11.	Tank	53,000.00
12.	Real estate	12,000.00
13.	Pumping station	9,000.00
14.	Main pumps	30,150.00
15.	Piping in pump house	1,500.00
16.	Boilers	12,000.00
17.	Chimney	4,272.00
18.	Wells	20,000.00
19.	Reservoir	11,730.00
20.	Pipes in station ground	10,000.00
21.	Furniture, tools, etc.	3,000.00
22.	Excavation and filling	1,800.00
23.	Going value	49,050.00
24.	Engineering & Superintendence	72,632.39
25.	Interest during construction	72,632.39
26.	Working capital	5,500.00

ITEMIZED ESTIMATE OF COST OF
WATERWORKS SYSTEM.

D. WELL SUPPLY.

56 miles of mains
494 hydrants

ITEM NO. 1 - STREET MAINS.

9,846.1	tons cast iron pipe	@ 33.40	$328,859.74
226	tons specials	@ 60.00	14,760.00
12,555	lbs. oakum	@ .09	1,129.95
38,844	lbs. lead	@ .05 1/4	2,039.31
		TOTAL	$346,789.00

ITEM NO. 2 - LAYING MAINS.

480	lin.ft.	30-inch pipe	@ 1.31	$ 628.80
16,460	lin.ft.	24-inch pipe	@ 1.14	18,764.40
3,700	lin.ft.	20-inch pipe	@ 1.08	3,996.00
6,800	lin.ft.	18-inch pipe	@ 1.05	7,140.00
14,390	lin. ft.	16-inch pipe	@ .78	11,224.20
14,140	lin.ft.	14-inch pipe	@ .67	9,473.80
23,380	lin.ft.	12-inch pipe	@ .58	13,560.40
11,390	lin.ft.	10-inch pipe	@ .49	5,581.10
25,300	lin.ft.	8-inch pipe	@ .41	10,373.00
69,916	lin.ft.	6-inch pipe	@ .37	25,868.92
109,480	lin.ft.	4-inch pipe	@ .33	36,128.40
9,800	lin.ft.	4-inch hydr.pipe	@ .33	3,260.40
			TOTAL	$145,999.42

ITEM NO. 3 - ROCK EXCAVATION

Present system - 30,180 lin.ft. - average depth 2.5 ft. equals 7,000 cu. yds.

Bluff Road	12,420 lin.ft.
9th St. Lyons	3,200 lin.ft.
8th Avenue, Lyons......................	1,840 lin.ft.
	17,460 lin.ft.

17,460 lin.ft.-2.5 av.depth,3' wide =	5,658.3	cu.yds.
Present system........................	7,000.0	" "
Extra	2,341.7	" "
	15,000.0	cu.yds.

15,000 cu. yds. rock excavation @ 2.50 $ 37,500.00

ITEM NO. 4 - PAVEMENTS OVER MAINS & HOUSE CONNECTIONS.

(Note: trenching thru and replacing)

MAINS - WIDTH OF PAVING THREE FEET.

Wood block	922	sq. yds.
Brick	9,490	" "
Concrete	2,862	" "
Old brick	15,317	" "
	28,591	" "

CONNECTIONS - WIDTH OF PAVING THREE FEET.

Wood block	57	connections
Concrete	276	"
Vitrified block	808	"
Old brick	1,114	"
TOTAL AMOUNT OF PAVING REPLACED	371	sq. yds.

COST OF CUTTING THROUGH PAVEMENTS AND REPLACING THEM AT $2.60 PER CU.YD.

	CUTTING	REPLACING	TOTAL
Wood block	.80	1.30	$ 2.10
Vit. block	.80	1,30	2.10
Concrete	.42	1.38	1.80
Old brick	.09	.51	.60

GRAND TOTAL

Wood block paving	922 sq. yds.	@ 2.10	$ 1,936.20
Vitrified block	9,490 " "	@ 2.10	19,929.00
Concrete	2,862 " "	@ 1.80	5,151.60
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			$ 36,429.60

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(b) Street railroad crossings: 653.75 lin. ft.	@ .40	261.50
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148 - 4-inch valves	@ 8.60	1,272.80
		$ 7,295.60

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ITEM NO. 9 - HOUSE CONNECTIONS.

4,263 - 5/8" connections	@ 23.00	$ 98,049.00
237 - 3/4" connections	@ 24.00	5,688.00
		$103,737.00

ITEM NO. 10 METERS.

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237 - 3/4" "	@ 14.60	3,460.20
		$ 46,090.20

ITEM NO. 11 - ELEVATED TANK.

Tank	$ 48,000.00	
Foundation	5,600.00	$ 53,000.00

ITEM NO. 12 - REAL ESTATE.

Waterworks site in Lyons Elevated tank site on Olney Ave.	$ 12,000.00

ITEM NO. 13 - PUMPING STATION.

6,992 sq. ft. (area of building)	$ 9,000.00

ITEM NO. 14 - MAINS PUMPS.

1 - 2 1/2 million gallon pump	$ 10,626.00
Freight	176.40
Foundation	497.60
	$ 11,300.00
2 - pumps	$ 22,600.00
1 - 1 1/2 million gallon pump	$ 7,000.00
Freight	150.00
Foundation	400.00
	$ 7,550.00

GRAND TOTAL

2 - 2 1/2 million gallon pumps	$ 22,600.00
1 - 1 1/2 million gallon pump	7,550.00
	$ 30,150.00

ITEM NO. 15 - PIPING IN HOUSE

	$ 1,500.00

ITEM NO. 16 - BOILER PLANT

4 boilers	$ 8,000.00	
Brick work	4,000.00	$ 12,000.00

ITEM NO. 17 - CHIMNEY.

89 feet	@ 48.00	$ 4,272.00

ITEM NO. 18 - WELLS COMPLETE $ 20.000.00

ITEM NO. 19 - RESERVOIR

805 cu.yds. concrete	@ 12.00	$ 9,660.00
48,160 lbs. rein. bars	@ .04	1,926.40
4,120 sq.ft. tri. mesh No.34	@ .03	123.60
1 door	@ 10.00	10.00
2 windows	@ 5.00	10.00
	TOTAL	$ 11,730.00

ITEM NO. 20 - PIPES IN STATION GROUND.

24 tons 12" c.i. pipe	@ 33.40	$ 801.60
Labor for same		650.00
1,444.8 cu.yds. rock excavation	@ 3.00	4,334.40
Pumping M. H.		1,612.00
8.4tons 24" c.i. pipe	@ 33.40	280.56
5 tons 12" c.i. pipe	@ 33.40	167.00
420 lin.ft. 24" vit. pipe	@ 1.00	420.00
710 lin.ft. c. i. pipe laid	@ 1.14	809.44
Outlet - extra		400.00
3-24-inch valves	@175.00	525.00
	TOTAL	$ 10,000.00

ITEM NO. 21 - FURNITURE, TOOLS, ETC. $ 3,000.00

ITEM NO. 22 - EXCAVATION AND FILLING?

2,530 cu. yds. earth excavation	@ .60	$ 1,518.00
564 cu. yds. filling	@ .50	282.00
		$ 1,800.00

ITEM NO. 23 - GOING VALUE.

YEAR	REVENUE	LOSS FOR NEW PLANT	SAVINGS IN OPER. EXP.	NET LOSS OR GOING VALUE
1917	$71300.00	$ 35,650.00	$ 3,200.00	$ 32,450.00
1918	72700.00	18,200.00	1,600.00	16,600.00
				$ 49,050.00

ITEM NO. 24 - ENGINEERING & SUPERINTENDENCE.	$72,632.39
ITEM NO. 25 - INTEREST DURING CONSTRUCTION	$72,632.39
ITEM NO. 26 - WORKING CAPITAL.	$ 5,500.00

APPROVAL

The foregoing thesis is hereby approved as a creditable study of an engineering subject carried out and presented in a manner sufficiently satisfactory to warrant its acceptance as a prerequisite to the degree for which it has been submitted. It is to be understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinions expressed or conclusions drawn therein, but approve the thesis only for the purpose for which it is submitted.

W S Kinne
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